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Assessment on Reducing Plastering Cost in Addis Ketema Sub City Condominium Project

BY

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Abstract

The government of Ethiopia gave huge attention for construction in the millennium development goal. Construction of condominium housing is one among the construction sector. The construction of condominium houses in Addis Ababa started in 2004 through Addis Ababa Integrated Housing Development Project in different sites. Addis Ketema sub city condominium project is one of the Addis Ababa Housing development project sites which are located in Akaki sub city. The project involves emerging contractors and Micro and small enterprises for the main construction works and the provision of prefabricated construction material respectively. Plastering work is one of the major finishing items included in the construction contract of condominium houses. However it is very common to see contractors complaining about the unit rate. And they consider it as a time consuming work because it is the stage that can correct any defect created on block work and concrete work. Therefore this paper justify plastering work is expensive in the project not because of the insufficiency of the unit rate; instead it is because of the cumulative effect of quality problem created at different stage of construction and excessive wastage.

CHAPTER ONE - INTRODUCTION

1.1 BACKGROUND

The construction of condominium houses in Addis Ababa started in 2004 through Addis Ababa Integrated Housing Development Project (AAIHDP). The program has an integrated approach to solve the housing shortage through mass construction of low cost houses and to reduce unemployment rate through engaging a large workforce in the construction process.

Accordingly, the project involves emerging contractors and Micro and small enterprises (MSEs) for the main construction works and the provision of prefabricated construction material respectively. The Housing Development Project Office is responsible for managing and administering of the project with the assistance of consulting firms engaged in the project as advisor and supervisors [1].

Addis Ketema sub city condominium project is one of the Addis Ababa Housing development projects which are located in Akaki sub city specifically two and half kilo meter away from Tirunesh Beijing memorial Hospital to the east. The site contains 95 residential blocks and 30 communal buildings. More than 35 contractors and too many small and micro enterprises are involved in this huge project.

The blocks are of two types. Which are E1 type and E2 type and both are G+4 buildings with a Total area of 1420 square meter for E1 type and 985 square meters for E2 type. The contract amount for each block is 1,828,408.10 br and 1,251,902.00 br respectively [2].

Plastering work is one of the major finishing items included in the contract document that holds more about 25% of the contract amount which contractors

are expected to be more sensitive to maximize their profit. However it is very common to see contractors complaining about the unit rate. And they consider it as a time consuming work, because it is the stage that can correct any problem created either on block work or concrete work. There is a bad trend in the site that whenever a defect in the block work or concrete work is observed, it is left to be corrected in the plastering work instead of searching for a solution at the time when it happened. That makes plastering work difficult and time taking.

1.2 STATEMENT OF THE PROBLEM

It is very common to see a very thick cement plastering on walls and ceilings in the site. But nobody question why are we are doing this we only get paid for thickness not more than 2.5 centimeter. Instead most contractors complain on the unit rate.

So it is the interest of the paper to assess the existing situation and to identify the major problems and to recommend feasible alternatives that can significantly reduce the plastering cost in the site.

1.3 RESEARCH OBJECTIVE

General Objective

The main objective of the paper is to assess the practice of plastering work in the site mainly in the economic aspect that most contractors complaining about its profitability. And to draw conclusions about what needed to improve the profitability without compromising the quality. And to give some hint for researchers who like to do further study.

Specific objectives

- To assess the current practice of plastering work in the site and evaluate according to the Ethiopian building standards and some international practices.
- To identify the factors those incur unnecessary plastering cost and suggest ideas that would help to reduce plastering cost.

1.4 SCOPE AND LIMITATION OF THE STUDY

The research is limited to the profitability of plastering work in relation with the quantity of mortar usage in Addis ketema housing project located in Akaki sub city area. The quality of concrete and block works with respect to size, dimension, level and plumb will be considered in the paper.

1.5 SIGNIFICANCE OF THE STUDY

The construction sector is one of the major sectors that the government of Ethiopia gave huge attention in the millennium development goal. Cement is one of the major resources which play a significant role in the sector. The country spends a lot for the production of cement which is considered not environmental friendly process as it uses nonrenewable resources.

Sand is also in scarce at every part of the country now a day. Therefore optimized use of these resources could play a significant role to achieve the millennium goal and would help to create an environment friendly area by reducing the emission of gases during the production cement.

It will help contractors to be profitable so as we could create financially strong contractors who can play their part for the development of the country.

CHAPTER TWO - LITRATURE REVIEW

2.1 DEFINITIONS

a) Cement plaster is a mixture of sand, Portland cement and water which is normally applied to masonry interiors and exteriors to achieve a smooth surface [3].
b) Plastering is the finishing coat which provides a good look and improves hygienic conditions in the building [4].
c) Plastering is the term used to describe the material spread over the surface of irregular and coarse textured wall, column and ceiling to provide a smooth, hard and leveled finish which can be painted for good appearance [5].

2.2 USES OF PLASTERING

Plastering gives strength to the structural members and helpful to reduce dampness in masonry during rainy season. It also helps in keeping the home clean from germ and dust. In exterior, it protect from heavy rains dusty winds, large variation in temperature or corrosive atmosphere [4].

Various cement-based plasters are also used as proprietary spray fireproofing products. These usually use vermiculite as lightweight aggregate. Heavy versions of such plasters are also in use for exterior fireproofing, to protect Liquefied petroleum gas(LPG) vessels, pipe bridges and vessel skirts.

The Wikipedia also says Plaster is a building material used for the protective and/or decorative coating of walls and ceilings and for molding and casting decorative elements. Another imprecise term used for the material is stucco, which is also often used for plasterwork that is worked in some way to produce relief decoration, rather than flat surfaces [3].

2.3 TYPES OF PLASTERING

The most common types of plaster mainly contain gypsum, lime or cement. But all work in a similar way.

a) Cement plastering

It is a mixture of sand, cement and water which is normally applied to masonry interior and exterior to achieve a smooth surface. Cement-based plastering could both be applied indoors and outdoors. The advantages of cement plaster its strength, hardness, quick setting time and durability [3].

b) Gypsum plastering (plaster of Paris)

It is produced by heating gypsum to about 300 degree Fahrenheit. When the dry powder is mixed with water, it reforms in to gypsum [3]. Gypsum-based plastering are used in interior plastering because of its more susceptible to moisture.

c) Lime plastering

Lime plastering is composed of lime, sand, hair and water in proportions varying according to the nature of the work to be done.

It is a mixture of calcium hydroxide and sand (or other inert fillers). CO_2 in the atmosphere causes the plaster to set by transforming the calcium hydroxide in to calcium carbonate (limestone) [4].

d) Heat resistant plastering

Heat Resistant Plaster is a replacement material for gypsum plaster where the temperatures are too high for gypsum plaster to stay on the wall. Heat Resistant Plaster is a fully blended fine powdered material which is mixed with water to a trowel able / floating consistency. Heat Resistant Plaster should be used on walls and chimney breasts where the temperature is likely to exceed 50°C particularly around the so-called “hole in the wall” type fires and stoves [4].

Over the years different plastering techniques have been innovated. The old and tested method of plastering are still used today but newer methods in terms of new materials or additives are now gaining popularity especially in interior plaster finishing.

2.4 APPLICATION OF PLASTER

Hand application-For hand application, the plasterer applies the plaster to the surface using a hawk and trowel. Only the plasterer can determine the amount of water needed to bring the plaster to the proper consistency.

Machine application-Plaster pumps are used to spray the plaster onto wall and ceiling surfaces. Batches of cementitious material, sand, and water are mixed in the hopper and continuously pumped onto the surface. The person operating the mixer controls the amount of mixing water. The person operating the hose (the nozzle man) controls the spray pattern of the wet plaster by adjusting the air jet, air pressure, and nozzle orifice size. Uniform dispersion is attained when the nozzle is held about 12 in. away from and perpendicular to the working surface [20].

2.5 COATS OF PLASTERING

Plaster is applied usually in two or three coats. The first coat is called the scratch coat, followed by the brown coat. Most applications call for a finish coat. Color and texture are generally properties of the finish coat. The thickness of the individual coats should be stated in the project specifications, and should conform to the requirements of ASTM C 926 (see Table 11.1) or UBC Table 47F (see Table 10.2) [20].

2.5.1 Scratch coat plastering

The scratch coat should be thick enough to provide a good bond between the plaster and the base. Avoid excessive troweling during hand application. After application, the scratch coat surface should be rodded plane, and vertical surfaces should be scored horizontally. The purpose of scoring is to provide a mechanical key between the scratch and brown coats. Deep scoring may cause voids between the scratch and brown coats.

2.5.2 Brown coat plastering

The brown coat is adjusted usually to carry more sand than the scratch coat, and it should be mixed according to local codes. Allow sufficient stiffening to occur prior to floating. The floating of the brown coat is required to reconsolidate the plaster coat. This densification process reduces the potential of cracking caused by shrinkage. The brown coat, regardless of application method, should be moist-cured for a minimum of 2 days. Check local codes and project specifications for variations of this curing schedule. Moisten the scratch coat with water before applying the brown coat to reduce the initial absorption of water. Allow the water sheen on the surface of the scratch coat to disappear before applying the brown coat.

2.5.3 Finish coat application

The finish coat plaster mixture, texture, color, and application method should be known before scratch and brown coats are applied. Properties of the first two coats can affect the finish coat appearance. Sample panels, if required, should be completed before any jobsite plastering starts. Immediately before applying the finish coat, moisten the base coat to control absorption during application and tooling of the finish[20].

The plaster shall be finished to a true and plumb surface and to the required degree of smoothness. The work shall be tested frequently as it precedes with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal surfaces shall be tested with a level and all jambs and corners with plumb bob as the work proceeds [7].

2.6 DELAY BETWEEN COATS

The traditional method of plastering requires a delay between the scratch and brown coats. The intent of this delay is to allow each coat of plaster to cure independently. The disadvantage of this method is that moist curing is required during the delay period. Additional costs may be incurred for labor and materials, and the delay will prolong the job.

Another accepted method of plastering is the "double back" application of successive coats with little or no delay between coats. By promoting better bond and more uniform curing throughout the base coat, this method eliminates the delay between coats as well as the moist curing requirement of the scratch coat.

When using the double back method, the full thicknesses of the scratch and brown coats are applied as rapidly as the two coats can be put in place. The brown coat should be applied only when the scratch coat is rigid enough to receive the brown coat without cracking from the pressure of the brown coat application. This procedure should be restricted to plaster on a solid base or lath that is applied over sheathed frame construction. Job conditions or project specifications may require different time periods between the scratch and brown coats, but prolonged delays should be avoided [20].

2.7 PLASTERING FINISHES:

There are four different types of finishes that can be obtained with cement plaster, as per the quality guide for cement plastering,

a) Smooth finish:

When a smooth finish is desired, the minimum amount of plastering should be applied to the wetted surface and the wooden float, rather than a steel trowel is to be used.

b) Roughcast finish:

This finish suitable for rural or coastal areas and the sever conditions of exposure. This is a finish, which is splashed on to the surface as a wet mix and left rough. The maximum sizes of sand, crushed stone or gravel vary from 12.5 mm to 6.3 mm [7].

c) Pebbledash finish:

This is most durable of all finishes and is generally free from defects. This gives a rough texture and is obtained by means of small pebbles or crushed stone, graded from 12.5 mm to 6.3 mm being splashed on to a fresh coat of mortar and left exposed [7].

This pebbles or stones are sometimes lightly pressed or tapped in to the mortar.

d) Textured finishes:

Textured finishes are now becoming very popular and may be obtained in a variety of ways in many different designs. Special effects can be obtained by scraping the surface of the rendering with a straight edge hacksaw blade or with the edge of a steel trowel [7].

2.8 THICKNESS OF PLASTERING

2.8.1 Recommended thickness of cement plastering

Brick wall	12mm to 20 mm
Rough side of 9" and 4.5" wall	15mm
Done in two coats in some cases on rough side of wall or according to the design requirement	20mm
RCC surface	6mm to 10mm
RCC ceiling/roof/belly of stair	10mm

Table 1 Recommended plastering thickness by uniform building code, California

The Uniform Building Code requires that the minimum finished thickness of cement plaster, applied over masonry walls, should be no less than 1.25cm. Naturally, there may be instances where one blocks projects outward beyond average alignment of the majority of blocks, over which plaster may be thinner than average. There may be instances where a block is somewhat recessed in relation to the balance of the wall, thus greater thickness would be required in that location. For these reasons, thickness of plaster overcoat must vary to accommodate inequalities in alignment of the block, brick or stone wall. The mean average thickness should be one-half inch or slightly greater. [8].

Mr. Geary on his article on stucco Guru says Oftentimes, average thickness of cement plaster over masonry in the range of about 1.56cm is suitable, but no

constant figure can or should be stated. Determining factors may vary from one project to another, and even over different areas of the same project. One important criterion is that the mean average thickness be held at or above one-half inch, with some variation probably occurring [9].

He also said, application of an excessively thick membrane of plaster over masonry (or concrete) must be avoided, or delaminating of plaster from the substrate may occur. A specific maximum thickness cannot be stated, again because determining factors may and frequently do vary on construction projects. Normally, about 1.87cm to about 2.5 cm thickness is a reasonable maximum depth; [9]. Although greater depth of application may be accomplished if careful control is exercised. If thickness greater than 1.87cm is needed or desired for a specific and justified reason, a thicker membrane may be built up over a concrete block wall, but only in a serious of applications each coat being no thicker than about 0.94cm. Sufficient time must be allowed between each coat [9].

The surface of lower coats must be left sufficiently open and receptive to a succeeding coat, in order that good bond will be attained. For thickness greater than 2.5cm, normally installation of metal lath should be considered.

Mr. Geary finally suggest, total mean average thickness of a membrane of cement plaster applied over a concrete block wall normally should be approximately 1.56cm. This average specified depth would allow for variation of greater or lesser thickness and still provide suitable coverage. Thickness of approximately 1.56cm would include the depth of a scratch coat, which might be approximately 0.16cm to 0.31cm; a base coat, which might be approximately 0.63cm to 0.94cm; plus the finish coat, which might be approximately 0.31 to 0.63cm thickness, if the finish is composed of gray cement plaster. If a color coat of stucco is to be applied, these figures could vary accordingly, because color coat stucco normally is applied in the range of about 0.31cm thickness [9].

Afrisam cement also recommends a plastering thickness of 20mm for two coats of cement plastering [10].

2.8.2 Local Code and Standard

Technical specification and method of measurement BaTCoDA

Most local construction agreements use Technical specification and method of measurement BaTCoDA standard 1991, for technical issues.

The contract agreement of the Addis Ketema housing project also used this document for any technical issues.

The first coat to be applied to a thickness ***of 5mm*** shall be spread by trowel, struck off level, and allowed to cure for 24 hours and the second coat shall be applied by trowel to ***a maximum thickness of 12mm*** [11].

The final coat of cement plaster to be applied on two coat plaster shall consist of one part of cement to two parts of fine aggregate complying with BS 1199 by volume applied by to a maximum thickness of 3mm [11].

2.8.3 International Codes and Standards

Indian standard

The code recommends the total thickness of two coats work shall not normally exceed 20mm. and it shall not exceed 15mm in the case of in situ concrete soffits. The thickness of three coats shall be about, but shall not normally exceed 25mm [12].

New Zealand Standard

Non Porous substrate	Bond coat	Flanking coat	Finishing coat	Total thickness
Concrete wall	3-4mm	9-15mm	2-3mm	14-22mm
Concrete ceiling	3-4mm	3-7mm	2-3mm	8-14mm
Concrete blocks & light weight concrete	3-4mm	9-15mm	2-3mm	14-22mm

Table 2 New Zealand standard for plastering thickness [13]

United States of America

The standard specification for application of cement based plastering work puts nominal plaster thickness for two coats as follows:

Two Coat Work	Vertical			Horizontal		
	1st coat	2nd coat	Total	1st coat	2nd coat	Total
Masonry	9.5mm	3mm	12.5mm			9.5mm
Cast in place or pre cast concrete	6mm	3mm	9.5mm			9.5mm

Table 3 united states standard for plastering thickness [14]

2.9 STEPS IN PLASTERING WORK

Cement plastering is commonly used as ideal coating for external and internal surface of wall. Cement plaster is usually applied in a single coat or double coat. Double coat plaster is applied where thickness of plaster is required to be more than 15 mm or when it is required to get a very fine finish. The process of applying a double coat cement plaster on wall surface consists of the following 4 steps [16].

- Step-1-Preparation of surface for plastering
- Step-2-Ground work for plaster
- Step-3-Applying first coat (or under coat or rendering coat)
- Step-4-Applying second coat (or finishing coat or fine coat)

Figure 1 plastering work application [16]

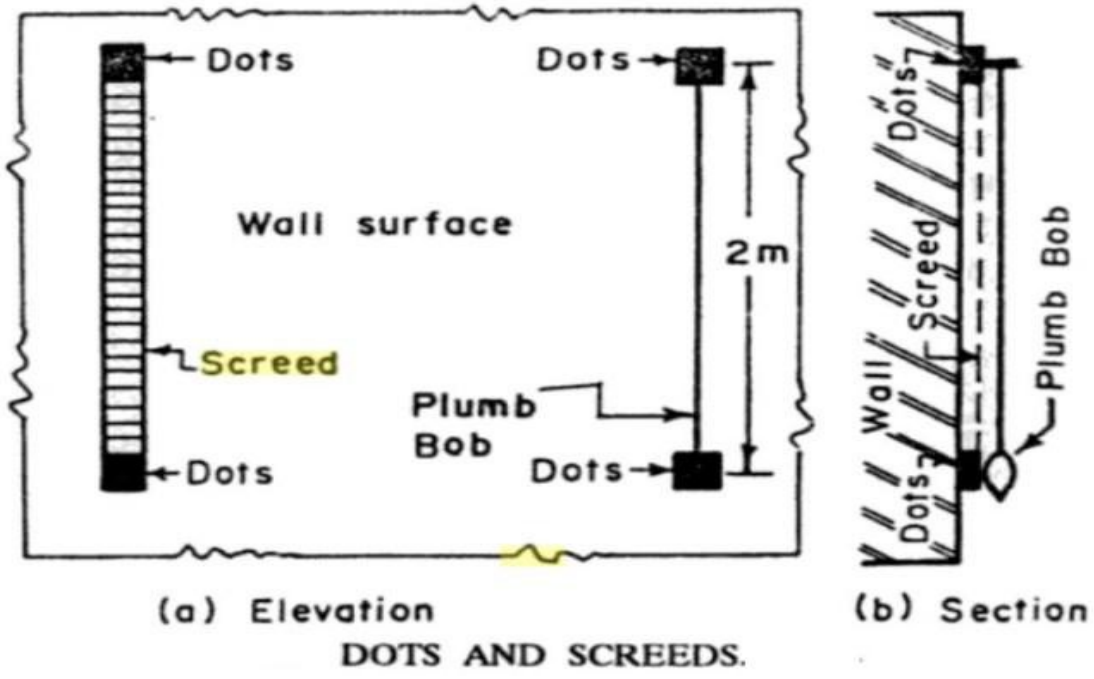

Figure 2 sketch showing how to check level of wall [16]

2.10 MIX RATIO FOR CEMENT SAND PLASTERING

RECOMMENDED MIX RATIO	THICKNESS OF PLASTERING
1:3 or 1:4 is recommended to RCC walls	6mm
On the wall where smooth side exist	12mm
1:3 in case of vertical damp proof course (DPC)	20mm
1:3 rendering or plaster in case of Dado.	15mm

Table 4 Recommended mix ratio for cement plastering [7]

2.11 DEFECTS IN PLASTERING

The following defects are listed on may arise in plaster work as listed on www.ustudy.in

1. **Blistering of plastered surface:** This is the formation of small patches of plaster swelling out beyond the plastered surface, arising out of late slaking of lime particles in the plaster
2. **Cracking:** Cracking consists of formation of cracks or fissures in the plaster work result in from the following reasons.
   i. Imperfect preparation of background
   ii. Structural defects in building
   iii. Discontinuity of surface
   iv. Movements in the background due to its thermal expansion or rapid drying
   v. Movements in the plaster surface itself, either due to expansion or shrinkage.
   vi. Excessive shrinkage due to application of thick coat
   vii. Faulty workmanship.
3. **Efflorescence:** It is the whitish crystalline substance which appears on the surface due to presence of salts in plaster making materials as well as building materials like bricks, sand, cement etc and even water. This gives a very bad appearance. It affects the adhesion of paint with wall surface. Efflorescence can be removed to some extent by dry bushing and washing the surface repeatedly.

4. **Flaking:** It is the formation of very loose mass of plastered surface, due to poor bond between successive coats.
5. **Peeling:** It is the complete dislocation of some portion of plastered surface, resulting in the formation of a patch. This also results from imperfect bond.
6. **Popping:** It is the formation of conical hole in the plastered surface due to presence of some particles which expand on setting.
7. **Rust Stains:** These are sometimes formed when plaster is applied on metal laths
8. **Uneven surface:** This is obtained purely due to poor workman ship [17].

2.12 MORTAR WASTAGE AND PLASTERING

The production of plastering waste was primarily due to excessive mixing/left over of mixed plaster, lost during applying and poor storage. Other sources of plastering waste included off-cuts, residues remained in spoiled bags and packaging. Other causes of waste are mixing too much mortar and spilling during its transport around the building site. Too much mortar being mixed creates residues in tubes, wheelbarrows, and mixer.

Waste of mortar was also observed in most sites during the handling and transportation operations, although no quantification was possible. Multiple handling of the same batch of mortar, due to intermediate stocks along the process flow, is also fairly common. Such waste was mostly related to site layout problems, lack of properly maintained pathways, and use of inadequate equipment [15].

CHAPTER THREE- RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter discusses the research design and methodology used in acquiring the necessary Information to answer the research questions. Lastly data were collected from documents such as contract documents, standards and guides.

The study focused on plastering works and its profitability in relation with the mortar quantity it has been used for a square meter area and the percentage of wastage with respect to standards and specification.

3.2 RESEARCH APPROACH AND TECHNIQUES

The strategy followed in this research was, first, to formulate the research design. Then data and information sources were determined based on the formulated research design. On the basis of the data and information sources the research instruments were decided. Then the required data were collected and analyzed. Finally, available documentary sources were reviewed for cross-checking the validity and conformity of the information obtained through the overall research work.

A descriptive and exploratory survey design was used in this study. It was attempted to collect data from the relevant population (contractors, client's representatives, consultants and foremen) to determine the practice of plastering work based on one variable. The variable in this study is thickness and mortar usage for plastering work in the study area. The research uses qualitative approach for data collection and analysis. To gather data, questionnaire is prepared for site engineers, contractors, consultants and foremen. Interviews were also carried out to selected respondents and the type of question was an open ended questions. In addition, observation and pictures were used.

3.3 DATA AND INFORMATION SOURCE

The samples were drawn from Addis Ketema sub city housing agency, Contractors, consultants, and relevant Professionals. Purposive sampling was used to collect the data. The respondents in the study were both men and women, who are owners of a company or occupying professional positions in the site. Both the relevant professionals and the owners of construction or consulting firm were purposely selected.

The questionnaire used in this paper was self administered questionnaire and interviewer administered questionnaire. The type of question used was a contingency question type. That means a second question above is what we refer to as a contingency question flowing up a closed ended question.

The interviewer administered questions were first prepared in English but carried out in Amharic by considering the capacity of the respondents to give satisfactory answers. Interview was also made to different professionals in the site.

3.4 POPULATION AND SAMPLING

The site is classified in seven batches geographically by the client for ease of management. And each batch contains thirteen blocks which has been constructed by five contractors. Two consulting companies are assigned for each batch. And the consulting companies have two resident engineers.

One contractor is chosen randomly from every batch for the questionnaire to represent five contractors

- Elevation factor, V=N/n
- Sample factor, n/N when N= population, n=sample

For this research out of the 35 contractors, 5 contractors were chosen systematically as follows.

First randomly chose a numbered element from1, 2, 3 ….N/n …and call it Xo, and then we take the following elements Xo, Xo+v, Xo+2v, Xo+3v …

For 14 consultants the same method was used to choose the sample. And five client representatives were used for the study.

This study employed primary and secondary data. The primary data were collected through questionnaires and interviews in the selected study area. The information gathered through both interviews and questionnaires was supplemented and verified by explanations based on literature review. A number of publications, researches, articles, standards in the subject matter were also used as a secondary data sources.

The data was analyzed using qualitative approach. Statistics like the percentage of respondents has also been used by using excel sheet to show the extent of the response.

ITEM NO	TYPE OF RESPNDANT	SAMPLE SIZE	DAT TYPE	DATA COLLECTION METHODS
1	Contractors/ site Engineers	5	Primary	Self administered Questionnaire
2	Consultants/ Supervisors	5	primary	Self administered Questionnaire
3	Clients/ resident Engineers	5	primary	Self-administered Questionnaire
4*	Forman	5	primary	Interviewer administered questionnaire

Table 5 Population and sample for questionnaire

CHAPTER FOUR- RESULT AND DISCUSSION

4.1 GENERAL

As described in the methodology part, the approaches adopted in this research were questionnaires, interviews, desk study and observation.

The desk study was conducted to check the international practice and standards vis-à-vis the local practice and standards. The result shows that specification for cement plastering of other countries is more or less similar to our standards. The ratio, thickness, and application of cement plastering are found similar to other countries experience.

The construction site was observed to assess the practice of cement plastering mainly focused on plastering thickness, wastage, level and plumb of walls and ceilings.

Interview was also made to foremen regarding factors affecting plastering thickness such as dimensions of blocks and precast beams supplied by SME, availability of good skilled manpower around the site and so on.

Self administered Questionnaires were distributed to fifteen professionals who are directly involved in the project to assess information such as plastering and its quality, factors that affect plastering quality and cost. And interviewer administered questionnaire were distributed to 5 foremen in the site.

A total of 18 questionnaires were returned and the response rate is about 90%. The detail of the survey questions are attached as appendix to this document.

Interview was also made to four contractors, four consultant resident engineers, four client representatives and five foremen.

RESPONDENT	QUESTIONNAIRE DISTRIBUTED	QUESTIONNAIRE RETURND	RETURN RATE
Contractors/site Engineers	5	5	100%
Consultants /supervisors	5	5	100%
Client representatives	5	4	80%
Foremen	5	4	80%
TOTAL	20	18	90%

Table 6 responses for questionnaire

4.2 EFFECT OF BLOCK WORK ON PLASTERING

According to the survey made in the site, 100% of the respondent confirmed that block work has been supervised at every stage by using plumb bob, level, and visual inspection.

72.73% of the respondents agreed that more than 50% of HCB block supplied in the site from the small and micro enterprises has problem on its size and dimension.

Despite the fact that most of the supplied HCB has dimension problem, almost all blocks has been used to construct the walls. And this is agreed by 85.7% of the respondents.

During the interview with the contractors foremen, 96% of them said they are forced to use the over size and the under size blocks because no one would accept them if they return it. Selecting better quality HCB blocks from the production site is also forbidden.

Workmanship also the major problems observed in the site according to the respondents. From the interview and visual assessment noticed that block works are not level, aligned and plumb. Edges are not good and angles are not sharp as well.

Generally 72.73% of the respondents said block work has been done in the site with poor quality with respect to level, and plumb. And among these respondents 18% of them said it is because of improper sized block production by the small and micro enterprises and 27.27% of them said poor workmanship and the remaining 54.73% said both improper sized blocks and workmanship are the cause.

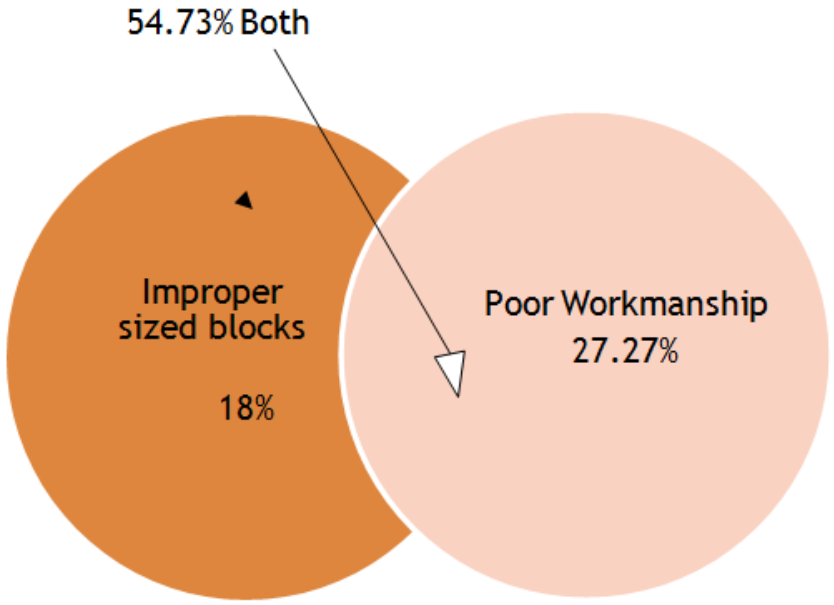

Figure 3 Reasons for poor quality Block work in the site by the respondents

4.3 EFFECT OF CONCRETE WORK ON PLASTERING

Concrete work quality in the site with respect to size and shape is ranked „‟ good‟‟ by 21.4% of the respondents, ranked „‟ fair‟‟ by 21.5% of them and 57.1% of them said size and dimension of concrete in the site is poor.

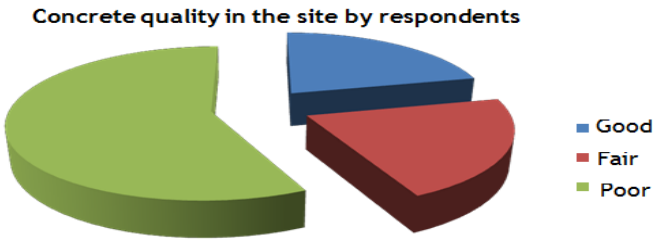

Figure 4 Concrete quality in the site by respondents with respect to size and dimension

Among the respondents who gave poor and fair to the quality of concrete with respect to size and dimension in the site, all of them have agreed formwork quality and workmanship are the main problems. Lack of supervision and negligence are also mentioned by some respondents.

From the interview, most Contractors (84%) said precast beams supplied by the small and micro enterprises have problems such as irregularity and over size. This irregularity in the shape of precast beams would cause sag on slabs. Therefore the only solution they do thick plastering to level the soffit.

Consultants and client representatives who have agreed on poor quality concrete production (79.4% of them), mentioned usage of very old formworks, loose bracings, props are not good enough to support the slab until the required time as a reason. Especially when they do the first floor slabs the props were fixed on natural earth. That causes the propos to sink in to the ground when the slab is casted. And the result will be sagged slab. And the remaining 20.6% of them mentioned different reasons such as negligence, using unskilled man power, and other reasons which are left out from this study because the percentage is very small.

The foremen also said, shortage of skilled manpower around the area is one of the causes for defective concrete.

Even though they have differences on the causes, majority of the respondents have agreed that size and dimension of concrete work in the site is in the range of not good and it has significant effect on plastering cost.

Figure 5 Chiseling Bulged beam

4.4 PLASTERING WORK

4.4.1 Profitability of Plastering

Regarding profitability of plastering work in the site, most of the respondents have agreed that it's not profitable. However they have difference on the reasons why it's not profitable.

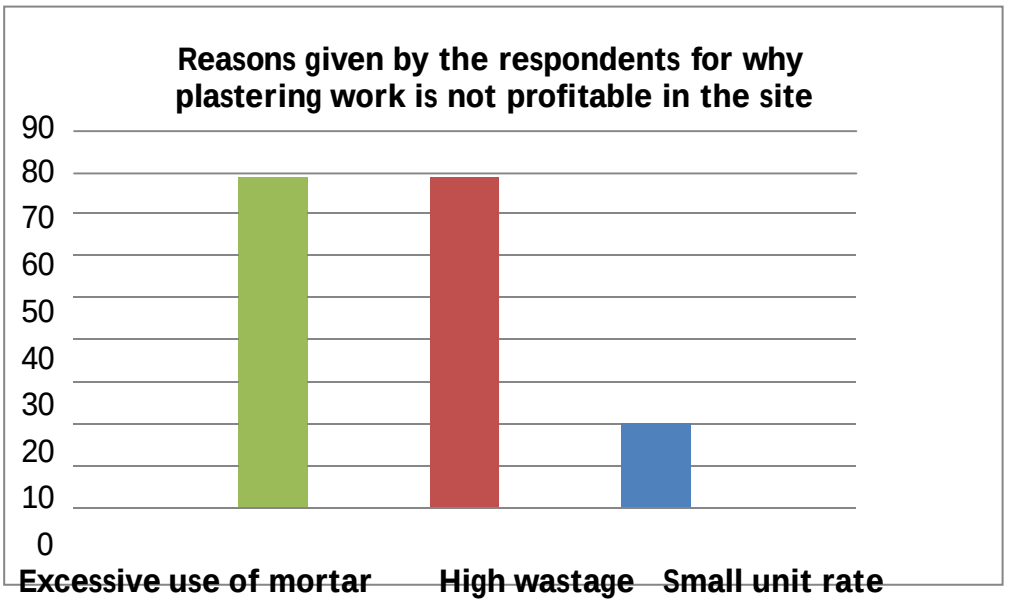

Figure 6 Reason given by respondents for concrete profitability

Among them 78.57% of the respondent said excessive usage of mortar to level the walls and slab soffit are the main reasons that make plastering work expensive. And 21.43% of them said the unit rate is too small.

Three contractors have said the unit rate is too small. And they really insist on correcting the rate. But other two contractors and other respondents agreed that it is not the unit rate which has problem rather it's the thickness of mortar they use to correct deformation of concrete structures and block walls which are out of plumb and level.

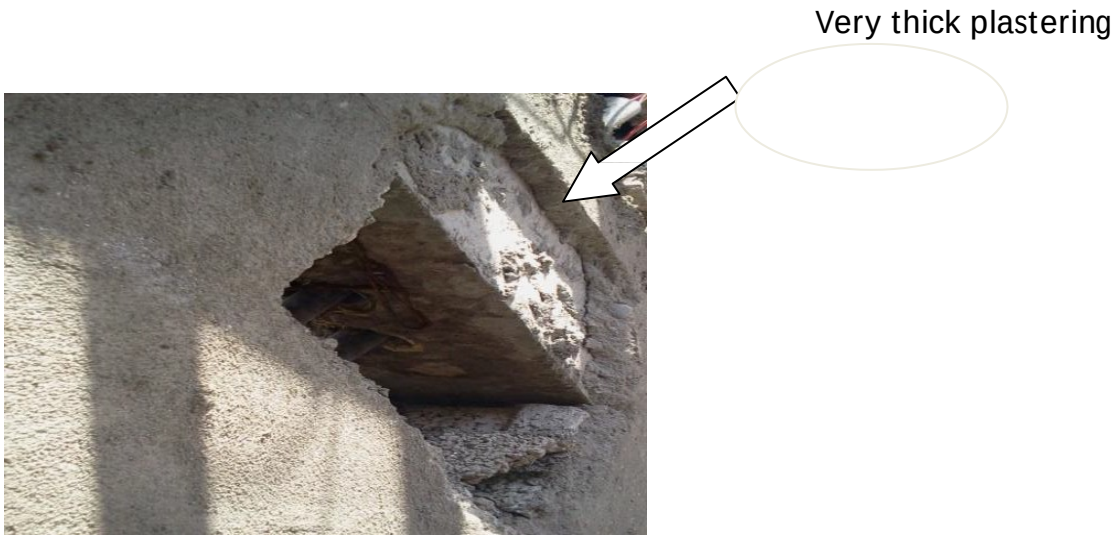

Figure 7 Thick plastering

4.4.2 Plastering Thickness

Plastering work is being done to an average thickness of 3.5cm in the site as 85.7% of the respondents and actual measurement made during visual assessment in the site.

Figure 8 Shows that nearly 4cm plastering thickness

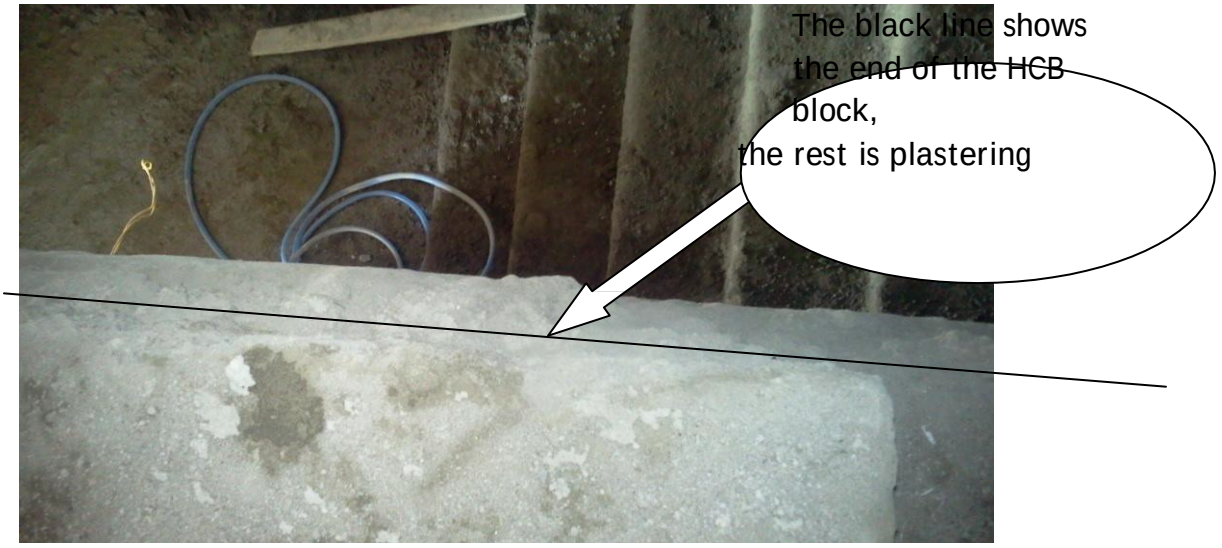

Figure 9 shows that more than 5cm thick plastering around stair case (block 2 E1)

As we have seen in the literature review, experts on *gharexpert.com* recommend a plastering thickness of 6 to 10mm for RCC surface and 15mm for two coats wall plastering and mr.Geary from stucco Guru industry India, suggest a

total mean average thickness 1.56mm plastering is enough for three coats on his article.

The technical specification and method of measurement BaTCoDA, which has been used for local contract agreement for technical issues says a maximum thickness of 17mm is ok for two coats of plastering.

And when we see other countries standard and specification, ASTM- the American society testing material suggests 17.5mm, Indian standards less than 20mm and New Zealand standards says 14 to 22mm for two coats wall plastering.

However the practice in the site shows an average thickness of 3.5mm. Which is a very huge gap with the standards.

4.4.3 Mortar Wastage

Wastage percentage according to the respondents

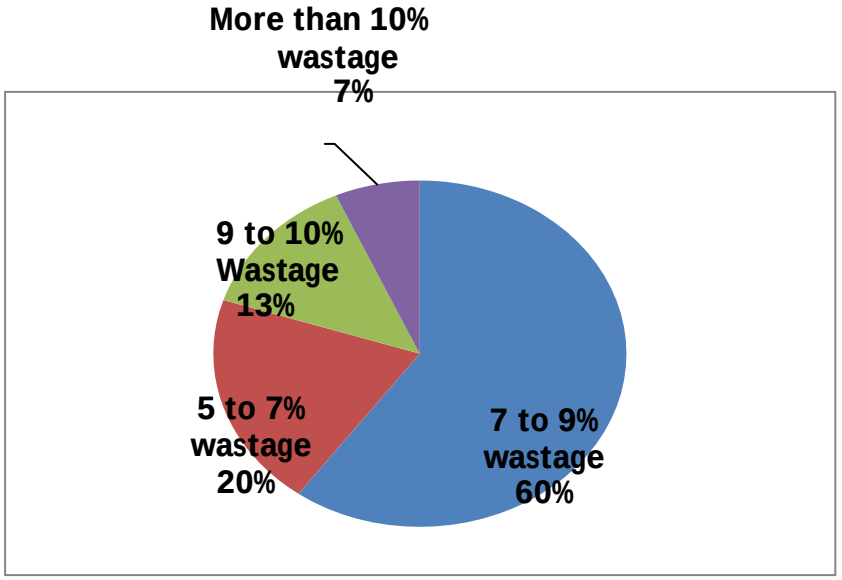

Figure 10 show wastage percentage in the site

Wastage is considered one of the major points that increase the material cost of plastering works in the site. The recommended amount of wastage in the calculation of mortar is 5 %(*cost estimation guide for works of building construction, 1992 from Building Design Enterprise*). However the practice in the site according to the respondents, 60% of them said its 7 to 9%, 20% said 5 to 7%, 13% said 9 to 10 % and 7 % said its more than 10%.

Finally, concrete works and block works are found the major work stages that determine the thickness of plastering and mortar usage. And secondly wastage is found another factor that incurs plastering cost.

4.4.4 Plastering Cost Calculation

On the tables under, the researcher has tried to calculate the unit rate of plastering work for different thickness. The first one is calculated for the unit rate which was fixed on the contract document.

The second one is calculated for 17mm thickness as per the BaTCoDA (technical specification and method of measurements recommendation.

And the last one is calculated as per the actual average thickness of plastering work in the site, which is 3.5 cm thick. On the last three tables, the paper tried to compare the effects of these plastering thicknesses on the total project amount.

FOR THICKNESS OF 2.5 EXCEL

FOR THICKNESS OF 3.5 EXCEL

FOR THICKNESS OF 17MM EXCEL

As shown in the first table, unit rate for plastering work was calculated 85br/m2 [2] with 5% wastage and 25 % shrinkage assumption [19].

However the actual cost that most contractors are really spending for plastering work including overhead cost and profit with a consideration of 8% wastage and 25% shrinkage is 112 br/m^2.

It has been also tried to calculate the possible plastering unit rate as per the technical specification and method of measurement suggestion(BATCODA), that is a 17mm thickness, it gives 71birr for square meter area which is less by 14 birr from the contract unit rate and less by 41 birr from the actual cost that contractors have been spending.

Note. *Work output and productivity data was taken from "cost estimation guide for works of building construction, 1992 from Building Design Enterprise"*

CHAPTER FIVE- CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

From the study conducted, the following conclusions were drawn.

Due to improper size and shape blocks and workmanship problem, block works are out of plumb and are not level. This problem on block works, makes plastering work expensive and time taking to fill and level the walls and slab.

Concrete Structures don't have the required shape. Columns and beams are bulged; slabs are sagged. Due to these problems plastering work is costly and time taking work in the site either to chisel the structure or fill with thick mortar to make it level.

Regarding profitability, it is found that plastering work is not profitable in the site. However, the reasons that make the contractors' loser in this specific item are not because of the insufficiency of unit rate, instead the quantity of mortar they use and high wastage.

Wastage is found high in the site as compared with standard and specifications.

Plastering thickness is very high in the site as compared to the national standard and other countries standards.

A significant amount of money can be saved from the entire project if plastering work is done as per the standard and specifications.

Therefore plastering work is expensive in the project not because of the insufficiency of the unit rate; instead it is because of the cumulative effect of quality problem created at different stage of construction and excessive wastage.

5.2 RECOMMENDATION

The following recommendations are given so that plastering cost and complains related to plastering work could be minimized:

- Small and micro enterprises should be supported and well supervised to produce a better quality hollow concrete blocks and precast beams so that block work quality can be improved and slab deflections can be minimized.
- Contractors should try to improve their quality of concrete with respect to size and dimension by giving full attention through all the process starting from formwork to casting stage. This improvement in size and shape of concrete help to minimize the volume of mortar could be used for plastering and the time and cost spending for chiseling defective concrete.
- Contractors should be sensitive on wastage minimization. It should be minimized to the allowable range. Mortar drops to the ground while plastering, should be collected immediately and reused. That would help to minimize mortar cost for plastering.
- Plastering work contains about 25% of the total work in the project. Therefore I strongly advise contractors to give a serious attention if they need to be profitable at the end of the project.
- Finally, I suggest a further study on city level, national level or on condominium projects on the minimization of plastering thickness. Because it will bring a significant change on total project costs.

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Annex

QUESTIONNAIR SURVEY

SECTION 1

GENERAL BACKGROUND

1. Type of your organization
   Contractor ☐ consultant ☐ client ☐ other ☐

2. What is your responsibility in the project?

3. Supervisor ☐ Site Engineer ☐ resident eng ☐ Foreman ☐

SECTION 2

1. How often does the work supervised?

   At every stage ☐ at every floor ☐ randomly ☐ not supervised ☐

2. What technique do you use to supervise block work?

   Plumb bob ☐ level ☐ visual inspection ☐ other_____

3. Do the HCB supplied from micro enterprises have the required size and dimension?

   yes, all have ☐ some of them ☐ no, more than 50% has defect ☐

4. If there is defective HCB, what do you do with it?
   use it ☐ use the better once ☐ dispose ☐
   all other_____

5. Do you think quality block work has been worked in the site? (Quality with respect to plumb and level only)

   Yes ☐ No ☐

6. If No, what do you think is the reason?

   Poor quality blocks ☐ poor workmanship ☐ Other_____

7. What do you think about the quality of concrete in the site? (Please focus on size and dimension only)

   Very good ☐ Good ☐ Fair ☐ Poor ☐

8. What do you think is the problem?

   Material quality ☐ formwork quality ☐ workmanship ☐

   Other_____

9. Do you agree that plastering work is not profitable? Yes ☐ No ☐

10. If yes, what do you think is the reason?

Too small unit rate ☐ excessive usage of mortar to level ☐

Poor workmanship ☐ other _____

11. Do you know that less than 3cm thickness was considered while unit rate was fixed?
Yes ☐ No ☐

12. What plastering thickness do you mostly observe in the site?

less than 3cm ☐ 3 to 5 ☐ more than 5 ☐

Other _____

13. Do you think there is high wastage of plastering mortar (more than the allowable) in the site?

Yes ☐ N o ☐

14. If you think it is more than the allowable, how much percentage do you give for the wastage?

5 to 7 ☐ 7 to 9 ☐ 9 to 10 ☐ more than 10 ☐

15. Do you think concrete work and block work quality has its own impact on plastering thickness in the site? (When we say quality please consider the shape, size, level and plumb of walls, sagging of slabs and deformation of structures only)

Yes ☐ No I don"t think ☐

16. Any suggestion to improve plastering work in the site?

_____

_____

Thank you

INTERVIWER ADMINSTERED QUESTIONNAIR SURVEY

SECTION 1

GENERAL BACKGROUND

1. Type of your organization

   Contractor ☐ consultant ☐ client ☐ other ☐

2. What is your responsibility in the project?

   _____

SECTION 2

1. How often does the work supervised ?

   At every stage ☐ at every floor ☐ randomly ☐ not supervised ☐

2. What technique do you use to supervise block work?

   plumb bob ☐ level ☐ visual inspection ☐ other _____

3. Do the HCB supplied from micro enterprises have the required size and dimension?

   Yes, all have ☐ some of them ☐ no, more than 50% has ☐ defect

4. If there is defective HCB, what do you do with it?

   Use it ☐ use the better once ☐ dispose ☐

   all other_____

5. Do you think block work is good with respect to level and plumb? Yes ☐ No ☐

6. If No, what do you think is the reason?

   Poor quality blocks ☐ poor workmanship ☐

   Other_____

7. What do you think about the quality of concrete in the site? (Please focus on size and dimension only)

   Very good ☐ Good ☐ Fair 2.1 Poor ☐

   ☐

8. What do you think is the problem?

   Material quality ☐ formwork quality ☐ workmanship ☐

Other_____

9. Do you know that less than 3cm thickness was considered while unit rate was fixed?

Yes ☐ No ☐

10. What plastering thickness do you mostly observe in the site?

less than 3 ☐ 3 to 5 ☐ more than 5 ☐

Other_____

11. Do you think there is high wastage of mortar (more than the allowable) in the site?

Yes ☐ N o ☐

12. Do you think concrete work and block work quality has its own impact on plastering thickness in the site?

Yes ☐ No I don"t think ☐

13. Any suggestion, recommendation to improve plastering work in our site?

_____

_____

_____

Thank you

INTERVIEW FORMAT date_____

Name (optional) _____

Your organization _____

Your responsibility _____

Who are the suppliers of hollow concrete blocks?

How is the shape and size of the blocks with respect to the standard?

How is the quality of block work in the site with respect to level and plumb?

If you think it is not good, what would be the reasons?

What can you say about the quality of concrete with respect to size and shape? (Slab,beams, columns…)

If you think it has problem, what do you think is the reason?

Do you think concrete and block works have effect on plastering? How?

What plastering thickness do you observe mostly in the site? Is it ok when you compare it with the standards?

What do you think is the reason?

How is plastering mortar wastage in the site?

What do you think is the reason?

Do you agree that plastering work is not profitable in the site? (85br/m2)

What can you recommend to reduce plastering thickness in the site?

ANALYSIS SHEET FOR DIRECT & INDIRECT UNIT COSTS

PROJECT: Addis Ketem Sub City condominium project HOURLY OUTPUT: 1.2 m2/hr

WORK ITEM: NE' ***Plastering Work, for an average thickness of 17mm***

TOTAL QUANTITY OF WOI 1 m2 mix Ratio 1:3, 5%watage and 25% shrinkage RESULT: **71 Br./pc**

Material Cost (1:01)					Labour (1:02)					Equipment Cost (1:03)			
Type of Material	Unit	Qty *	Rate	Cost per Unit	Labour by Trade	No.	UF	** Indexed Hourly Cost	Hourly Cost	Type of Equipment	No.	Hourly Rental	Hourly Cost
cement	Kg	7.83	2	15.66									
sand	m3	0.017	466.00	7.922	Forman	1	0.5	15	7.5				
					plasterer	1	1	15	15				
					ass.plasterer	2	1	10	20	tools	3	0.2	0.6
Total (1:-01)				**23.582**	**Total (1:02)**				**42.5**	**Total (1:03)**			**0.6**

A= Materials Unit C **23.6** Br./pc

B=Manpower Unit Cost **35.4** Br./pc

Total of (1:02)

Hourly Output

C= Equipment Unit Cos **0.50** Br./pc

Total of (1:03)

Hourly output:

Direct Cost of work item = A+B+C =	……		59.50 Br./pc
Overhead Cost:	……	10%	5.95 "
Profit Cost:	……	10%	5.95 "
Total Unit Cost for one pad:	……		***71.40*** "

ANALYSIS SHEET FOR DIRECT & INDIRECT UNIT COSTS

PROJECT: Addis Ketem Sub City condominium project HOURLY OUTPUT: 1.2 m2/hr

WORK ITEM: NE' ***Plastering Work, for an average thickness of 25mm***

TOTAL QUANTITY OF WOI 1 m2 mix Ratio 1:3, 5%watage and 25% shrinkage RESULT: **85 Br./pc**

Material Cost (1:01)					Labour (1:02)					Equipment Cost (1:03)			
Type of Material	Unit	Qty *	Rate	Cost per Unit	Labour by Trade	No.	UF	** Indexed Hourly Cost	Hourly Cost	Type of Equipment	No.	Hourly Rental	Hourly Cost
cement	Kg	11.5	2	23									
sand	m3	0.025	466.00	11.65	Forman	1	0.5	15	7.5				
					plasterer	1	1	15	15				
					ass.plasterer	2	1	10	20	tools	3	0.2	0.6
Total (1:-01)				**34.65**	**Total (1:02)**				**42.5**	**Total (1:03)**			**0.6**

A= Materials Unit C **34.7** Br./pc B=Manpower Unit Cost **35.4** Br./pc C= Equipment Unit Cos **0.50** Br./pc

Total of (1:02) Hourly Output

Total of (1:03) Hourly output:

Direct Cost of work item = A+B+C = …… 70.57 Br./pc

Overhead Cost: …… 10% 7.06 "

Profit Cost: …… 10% 7.06 "

Total Unit Cost for one pad:…… ***84.68*** "

Remark _____

ANALYSIS SHEET FOR DIRECT & INDIRECT UNIT COSTS

PROJECT: Addis Ketem Sub City condominium project HOURLY OUTPUT: 1 m2/hr

WORK ITEM: NE' ***Plastering Work, for an average thickness of 35mm***

TOTAL QUANTITY OF WOI 1 m2 mix Ratio 1:3, 8%watage and 25% shrinkage RESULT: **112 Br./pc**

Material Cost (1:01)					Labour (1:02)					Equipment Cost (1:03)			
Type of Material	Unit	Qty *	Rate	Cost per Unit	Labour by Trade	No.	UF	** Indexed Hourly Cost	Hourly Cost	Type of Equipment	No.	Hourly Rental	Hourly Cost
cement	Kg	16.6	2	33.2									
sand	m3	0.036	466.00	16.776	Forman	1	0.5	15	7.5				
					plasterer	1	1	15	15				
					ass.plasterer	2	1	10	20	tools	3	0.2	0.6
Total (1:-01)				**49.976**	**Total (1:02)**				**42.5**	**Total (1:03)**			**0.6**

A= Materials Unit C **50.0** Br./pc B=Manpower Unit Cost **42.5** Br./pc C= Equipment Unit Cos **0.60** Br./pc

Total of (1:02) Hourly Output

Total of (1:03) Hourly output:

Direct Cost of work item = A+B+C = ……		93.08	Br./pc
Overhead Cost: ……	10%	9.31	"
Profit Cost: ……	10%	9.31	"
Total Unit Cost for one pad:……		***111.69***	"

Remark _____